



# **Carbon Sequestration: Opportunities for Methane Digesters in the Carbon Markets**

**Waste to Energy Workshop for the Farm  
Huntingburg, Indiana  
December 11, 2006**

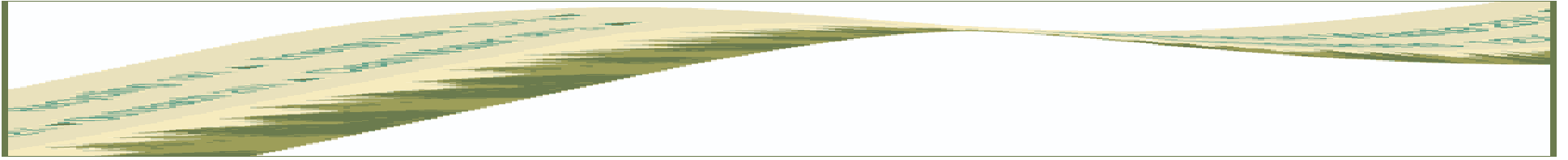




# Presentation Overview

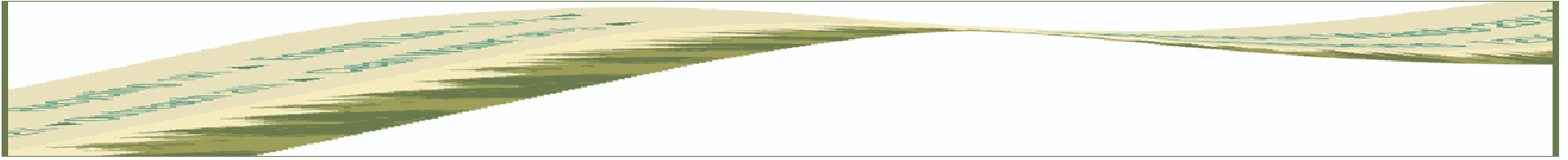
- Overview
- Roles and Responsibilities
- Anaerobic Digester Eligibility
- Contracting
- Verification
- Trading
- Payments





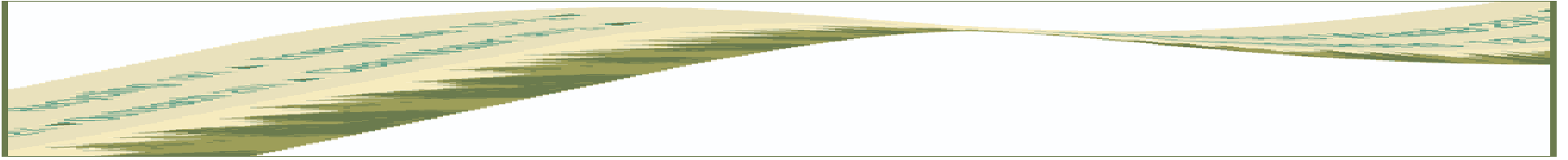
# Overview

- **Farmers/landowners earn greenhouse gas emissions credits** when they use conservation tillage, plant grasses and trees, or capture methane with manure digesters.
- **Conservation practices** store carbon in the soil and plants. Manure digesters produce energy and prevent methane from being released to the atmosphere.
- **Credits are aggregated** from many landowners and sold through the Chicago Climate Exchange (CCX®).



## About the Chicago Climate Exchange

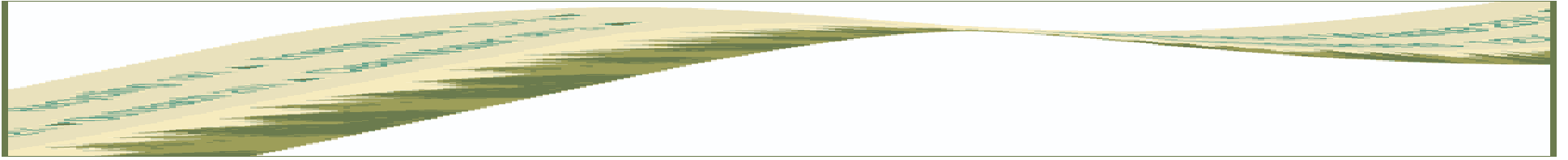
- Voluntary, legally binding.
- Cap and trade. Members reduce emissions and/or buy credits
- Members include: Ford Motor Company, City of Chicago, Waste Management.
- Reduce GHG emissions 4% between 2003 and 2005 and an additional 2% between 2006 and 2010. Members joining after 2005 agree to reduce GHG emissions by 6% between 2006 and 2010.
- Since its inception in 2003, 19,160,680 metric tons of CO<sub>2</sub> reduced - 8% overall reduction.



# About the Delta Institute

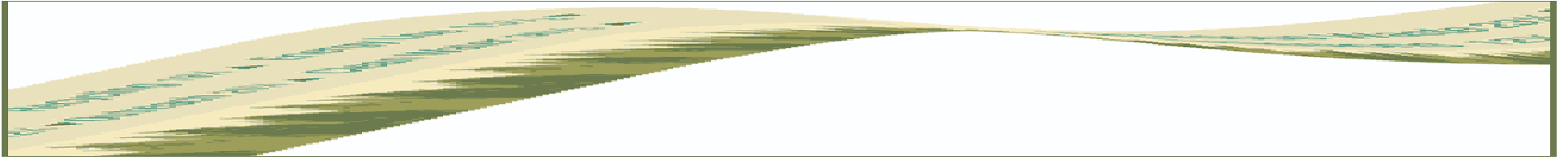
The Delta Institute is a Chicago-based non-profit organization promoting environmental quality and community development in the Great Lakes region

- **Aggregator** for carbon offset credits.
- **Trade credits** on the CCX® platform
- **Reimburse** project owners
- **Program reporting** to the Advisory Committee and CCX®



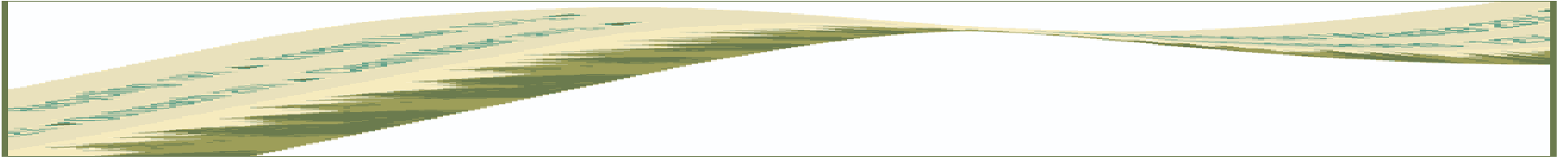
# Eligibility

- Project owners may directly register with CCX® if the project yields more than 10,000 metric tons of CO<sub>2</sub> per year.
- **Methane projects** implemented after January 1, 1999 with necessary biogas flow or electric output monitoring equipment:
  - 18.25 metric tons CO<sub>2</sub> per ton of methane per year.
- No minimum contract for methane offsets (XMOs).



# Eligibility

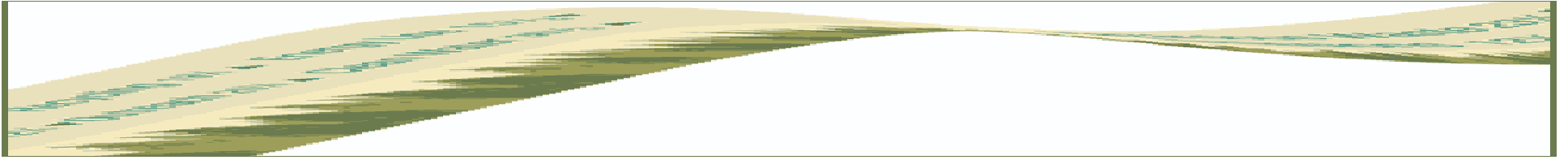
- Standards of practice found in the U.S. EPA National Resource Conservation Service for Anaerobic Digesters.
- Demonstrate clear ownership rights of the project owner to the greenhouse gas emissions registered with CCX®.
- Demonstrate eligibility of the site to earn XMOs.
- Keep and maintain records of methane content and total gas flows or total electricity generated from the project.



# Contracting

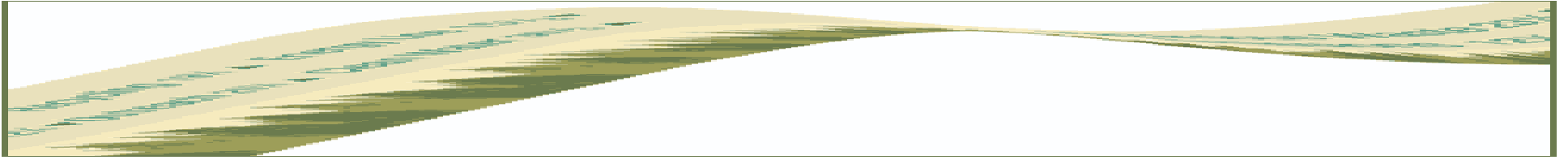
- Contract is between the Delta Institute (CCX approved aggregator) and the project owner.
- Separate contracts for Methane Offset Credit- XMO-projects.
- Contracts stipulate the program requirements and give the Delta Institute the right to trade the carbon offset credits.
- There are no minimum contract periods for Methane Offset projects.





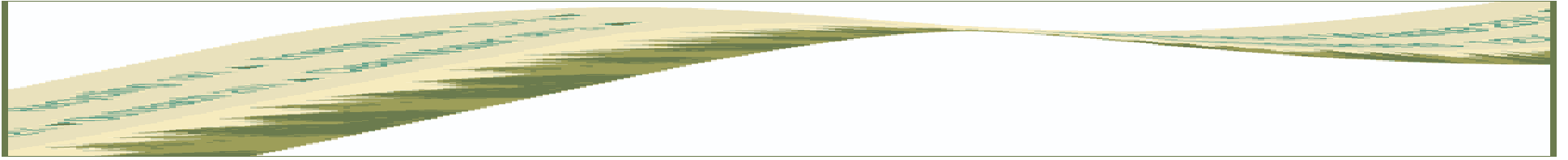
## Verification- Methane Digesters

- The third party verifier will visit each project location to verify that the proper equipment is installed.
- Carbon offsets can be traded after the verification report is received and accepted.
- Verification can occur any time of the year and usually occurs more than once per year.
- The first year verification includes a site visit. Subsequent verifications may not require a site visit unless there has been equipment changes.



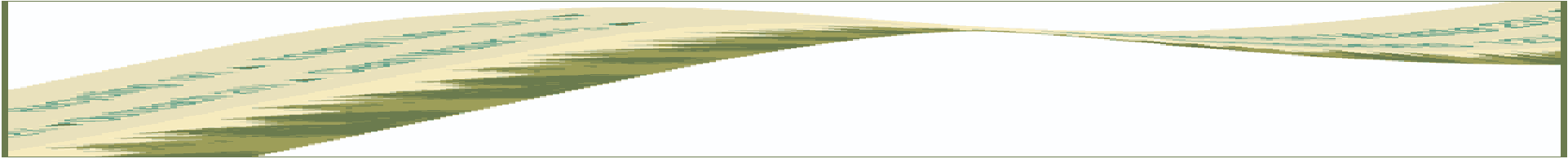
# Trading

- As an aggregator, the Delta Institute can trade carbon offset credits on the CCX® platform.
- Carbon offsets can only be traded once verification has occurred and has been accepted by CCX®.
- 80% of the credits can be traded- 20% is required to remain in an off-set pool owned by the project owner that is sold at the end of the contract period.
- Trades are conducted in blocks of 100 metric ton units.
- On December 4, 2006, carbon was trading at approximately \$4.25 per metric ton according to the vintage year.



# Payments

- Once carbon offsets are traded, the funds from the trade will be placed by CCX® in an account maintained by the Delta Institute.
- CCX® trading fees will be deducted from the proceeds from the trade on a per metric ton CO<sub>2</sub> basis.  
\$0.14/metric ton of CO<sub>2</sub> traded.
- An aggregation fee of 8% will also be deducted from the gross proceeds.
- The Delta Institute will provide payments to the project owners based on metric tons of carbon traded.



# Methane Digester Example

An anaerobic digester combusts 20,000,000 cubic feet (approximately 1,000 head dairy) of biogas per year (60% methane, 40% CO<sub>2</sub> mix). Equivalent to approximately 4,130 metric tons of CO<sub>2</sub>.

***Value of carbon offsets = 4,130 x \$4.00*** ***\$16,520***

*CCX Trading Fee = 4,130 x \$0.14* *\$578*

*Aggregator Fee = \$16,520 x 8%* *\$1,322*

*Verification (Year 1)- Approximate* *\$3,000*

*Verification (Year 2)- Approximate* *\$1,500*

***TOTAL Fees (Year 1)*** ***\$4,900***

***Payment to Project Owner (Year 1)*** ***\$11,620***

***Payment to Project Owner (Year 2)*** ***\$13,120***



# Example Digester Carbon Paybacks

Farm Type	Herd Size	Manure Waste Generated (gpd)	Electric Generation (kW/yr)	Estimated Biogas Generation (cf/yr)	Estimated Methane Produced (metric tons/year)	Potential Carbon (metric tons/year)	Potential First Year Revenue from Sale of Carbon Credits (\$)
Dairy	1100	30,000	1,600,000	21,900,000	199	3,631	\$9,854
Dairy	725	35,000	876,051	25,550,000	232	4,236	\$11,996
Dairy	840	22,000	1,095,000	18,834,000	171	3,123	\$8,054
Dairy	3750	115,000	NA	83,950,000	763	13,919	\$46,274
Dairy	1400	38,000	1,500,000	17,383,333	158	2,882	\$7,203
Dairy	1000	20,000	NA	14,600,000	133	2,421	\$5,569
Dairy	2400	50,000	NA	43,800,000	398	7,262	\$22,708
Dairy	700	17,000	NA	12,410,000	113	2,058	\$4,284
Swine	2300	NA	NA	7,884,000	72	1,307	\$1,627

Price of carbon based on recent market value of \$4.00 per metric ton

Carbon generated is methane produced multiplied by 18.25 tons CO<sub>2</sub> per ton of methane

     = Estimate based on gpd of manure

Methane generation ranges from 82 to 102 CF/Cow/Day

Electrical generation range from 1071 Kwh/Cow/yr

Methane generation ranges from 2 to 4 CF/gallon of manure



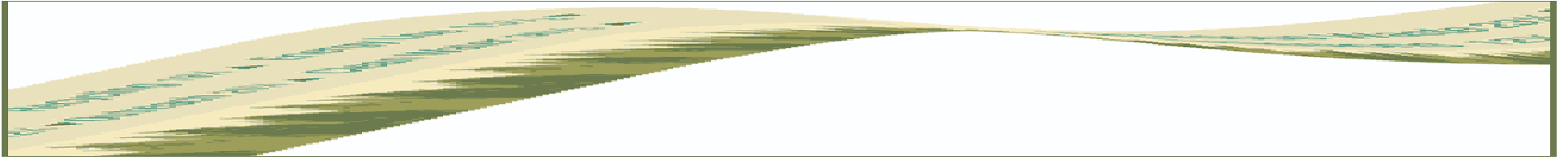


## Background Calculations

$$[\text{CH}_4 \text{ recovered (standard ft}^3\text{/hour)}] = [\text{average biogas recovery rate (standard ft}^3\text{/hour)}] \times [\text{average hourly \%CH}_4].$$

$$\text{Methane recovery (ft}^3\text{)} = [\text{kWhr of electricity produced from the biogas fuel}] \times [\text{heat rate in Btu/kWhr}] / [1012 \text{ Btu/ft}^3 \text{ (HHV of methane)}]$$

$$\text{CH}_4 \text{ combusted (Mg/yr)} = [\text{CH}_4 \text{ recovery (ft}^3\text{/yr)}] \times [16 \text{ (molecular weight of CH}_4\text{)}] \times [1\text{Mg}/10^6 \text{ g}] \times [1\text{mol}/24.04\text{L @ STP}] \times [28.32\text{L}/1\text{cf}]$$



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